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C5F
(71) Applicants
Lucas Industries plc
(Great Britain),
Great King Street,
Birmingham B19 2XF
(72) Inventors
Joachim Forster
(74) Agents
Marks and Clerk,
Alpha Tower, ATV Centre,
Birmingham B1 1TT

(54) Hydraulic fluid, and water content thereof

(57) A hydraulic fluid, e.g. a brake fluid, the water content of which is to be monitored up to an upper limit by conductivity measurements, has its conductivity increased by adding a carboxylic acid or salt thereof e.g. sodium salicylate, an alkanolamine e.g. an ethanolamine, an amide or a thioamide which is soluble in the fluid and in any water present therein to form ions, thereby improving the accuracy in measurement.

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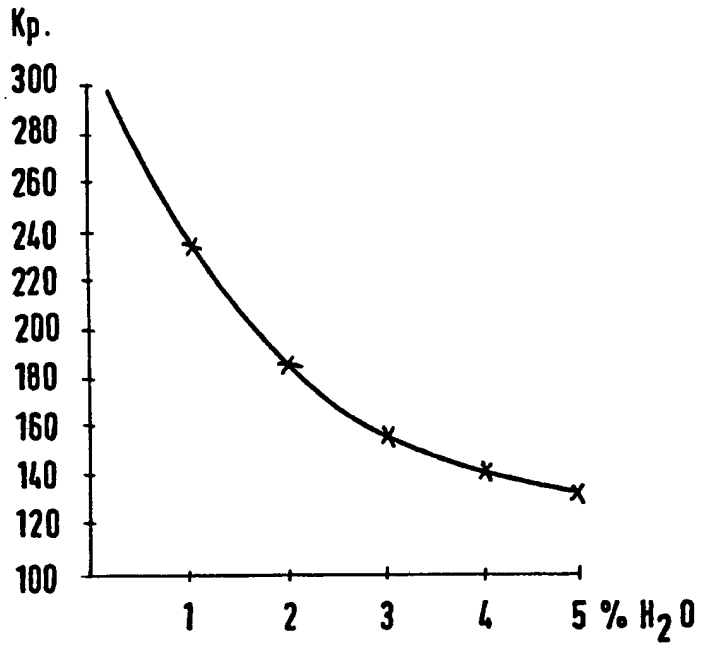
Kp.
300
280
260
240
220
200
180
160
140
120
100
1
2
3
4
5 % H_2O

FIG. 1

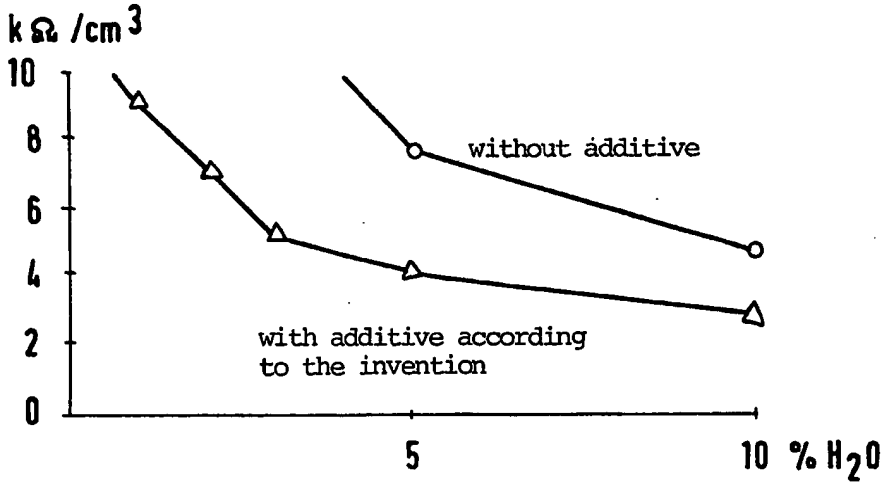
k Ω /cm 3
10
8
6
4
2
0
without additive
with additive according
to the invention
5
10 % H_2O

FIG. 2

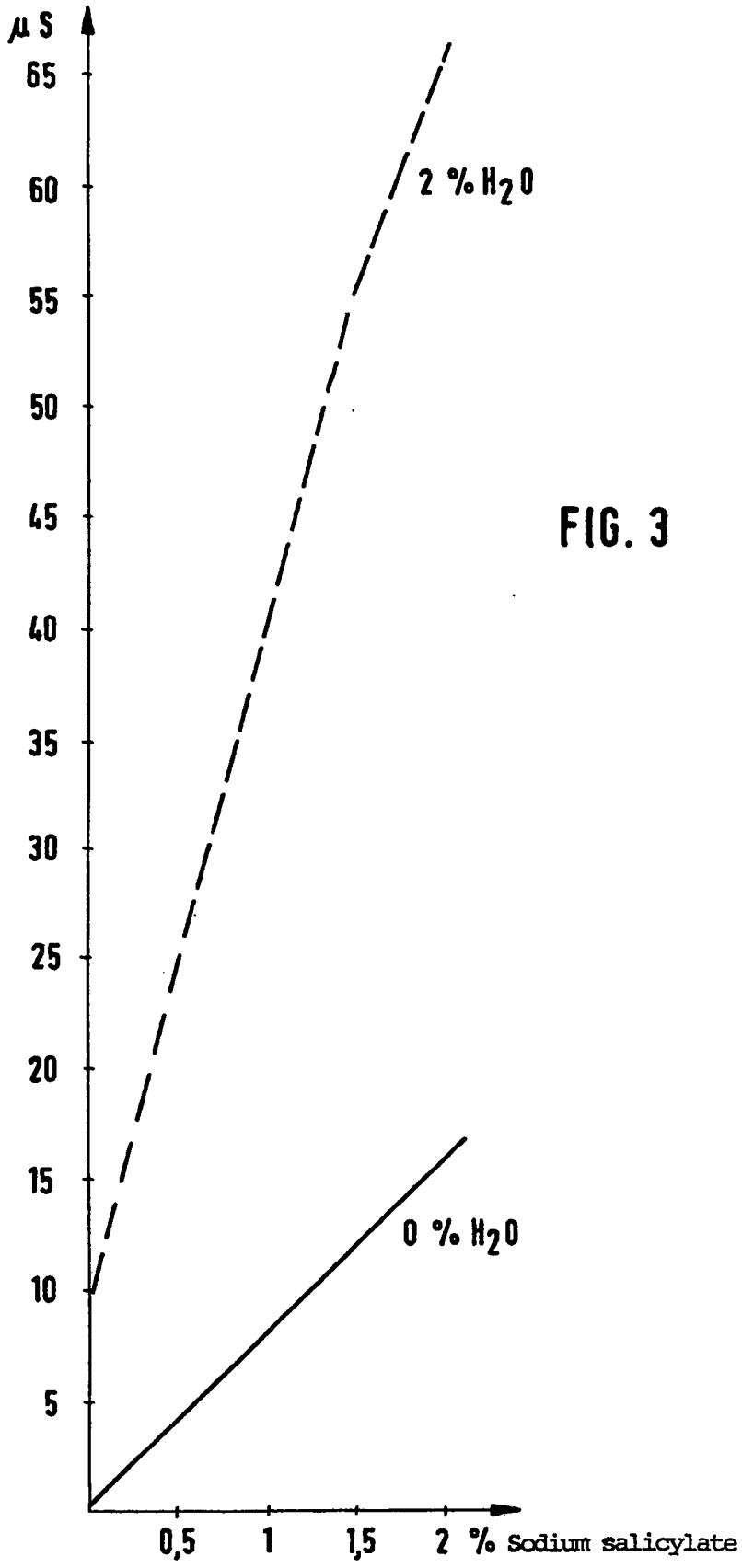
µS
65
60
55
50
45
40
35
30
25
20
15
10
5
2 % H_2O
0 % H_2O
0,5
1
1,5
2 % Sodium salicylate

FIG. 3

SPECIFICATION

Hydraulic fluid, in particular brake fluid

The invention relates to hydraulic fluids, in particular brake fluids, the water content of which is to be determined by means of conductivity measurements.

Hydraulic fluids generally consist of mineral oils or synthetic products on the basis of polyglycols and/or polyglycol ethers of the general formula

$$R_x—(OC_2H_4)_n—OC(CH_3)_3,$$

i.e. alkyl-polyethylene glycol tertiary butyl ethers, wherein the alkyl group may be straight-chain or branched and contains 1 to 4 C-atoms. The number of ethylene glycol units n is generally between 2 and 10.

It is known that these products tend to absorb water, i.e. they are hygroscopic. The boiling point of the anhydrous products is in the order of about 280°C. Through the hygroscopic capacity of the basic substances in the hydraulic fluids, their water content constantly increases with longer service life. The increase in water content is, however, accompanied by a considerable decrease in the boiling point of the hydraulic fluids. With a corresponding water content, the boiling point may be only about 150°C and less (see Fig. 1).

It is known that this tendency, which the hydraulic fluids have due to the water content, imposes far-reaching restrictions on the efficiency of the machines and units using the hydraulic fluid, particularly on the operating reliability of motor vehicle brakes. It is likewise known that hydraulic units, above all motor vehicle brakes, can reach very high temperatures in a short space of time. Thereby the water in the hydraulic fluid evaporates and any resultant bubble formation can lead to complete brake failure.

It is known that the water content of fluids can be detected by determining the electric conductivity — or the converse value, the specific resistance. A measuring instrument intended for this is known from German Offenlegungsschrift No. 29 29 784.

Under virtually anhydrous conditions (0% water), the electric conductivity of commercial hydraulic fluids is about 0.5 μS and reaches about 8 μS with just 2% water. When the water content is higher, the conductivity rises further.

A water content of only about 2% in a hydraulic fluid leads to the boiling point falling from e.g. 280°C to about 200°C.

As indicated above, the conductivity values of a hydraulic fluid containing 0 to about 2% water are very low. Therefore the most exacting demands are to be made on the precision of the instruments measuring the conductivity to determine the water content and they can hardly be satisfied by instruments for petrol and service stations.

Hitherto the vehicle owner was obliged to periodically change all the brake fluid to obviate the said safety hazard. The attempt has also been made of now and then taking a sample from the brake fluid and determining its boiling point. Apart from the fact that this is a very unhandy method, there is the danger of dirt getting into the brake fluid through such manipulation. Since such complicated tests can also be made only at relatively long intervals for reason of the expense, they do not represent any solution to the problem at issue.

There is therefore an urgent need for the person responsible for the hydraulic system, in particular the driver, to be given an indication when the water content of the hydraulic fluid, in particular the brake fluid, has risen so far and there has thus been such a drop in the boiling point that the operating reliability of the system, in particular the vehicle brake system, is no longer ensured.

In determining the water content of a hydraulic fluid by measuring the conductivity or the specific resistance, the conductivity of this fluid is related to the conductivity of the anhydrous fresh hydraulic fluid.

Preferably, parallel measurements are made of the fluid for testing and the fluid for comparison, these permitting the water content and thereby the operating reliability of the hydraulic system to be directly deduced. Such equipment may, for instance, be installed in a motor vehicle to monitor the water content of the brake fluid by optical or acoustic indication until a predetermined limit is reached. Where high resistances are to be measured, however, slight changes in resistance may be masked by errors in measurement and/or noise, unless unduly exacting demands are made on the measuring equipment. The higher the resistance to be measured is, the higher are the requirements made on the equipment and hence the expense.

The invention aims at making it possible in practice to monitor hydraulic fluid, in particular brake fluid, by constantly or periodically determining the conductivity and thereby the water content. A relatively simple and inexpensive system is required to determine the resistance of the hydraulic fluid, in particular the brake fluid, in the order of $<10\ k\Omega/cm^3$, at least when the water content of the fluid approaches the dangerous range. Generally, however, commercial hydraulic fluids, in particular brake fluids, have far higher resistance values. Therefore the call for a simple measuring system to determine the water content involves the reduction of the specific resistance of the fluid.

It is hence an object of the present invention for the specific resistance of the hydraulic fluid, in particular a brake fluid, to be considerably reduced or for its conductivity to be increased.

According to the invention, the object is accomplished by adding organic carboxylic acids or the salts thereof or ethanolamines, said additive being soluble in the fluid and any water present while forming ions. Hence there is added to the hydraulic fluid a substance which is dissociable in solution while forming ions and has sufficient solubility both in the anhydrous fluid and in water.

Figure 2 shows the correlation between the specific resistance of a hydraulic fluid and the water content with and without the additive according to the invention. This diagram shows that without the additive according to the invention and with a water content of 1 to 2%, this being considered to be the maximum permissible water content for safety reasons, the resistance of the hydraulic fluid is considerably above 10 $k\Omega/cm^3$. Therefore under the normal maintenance and operating conditions of a motor vehicle, there may be inaccurate measurements. However, with the additive according to the invention and with the same water content of 1 to 2%, the resistance is substantially reduced, i.e. to $<10\ k\Omega/cm^3$, thereby enabling accurate measurements with simple means.

It has unexpectedly proved that specific substances, namely organic acids and the salts thereof — if they have the necessary solubility — lead to a particularly large increase in the conductivity of the hydraulic fluids. The carboxylic acids or the salts thereof to be employed according to the invention may be aliphatic mono or polycarboxylic and hydroxycarboxylic acids such as lactic acid, citric acid and possibly also soluble salts of tartaric acid. Aromatic mono and dicarboxylic acids and hydroxycarboxylic acids such as salicylic acid or 2,5-dihydroxy benzoic acid and the salts thereof are also used for accomplishing this object. Various ethanolamines as well as (thio) acetamide are also suitable. The salts of salicylic acid, in particular sodium salicylate, have proved to be particularly suitable, whereas sodium benzoate does not yield quite as good results yet nevertheless leads to a distinct increase in the conductivity of the hydraulic fluid.

It is especially remarkable that through the additives according to the invention, the conductivity of the hydraulic fluid is not increased by a specific amount — independently of the water content — i.e. for instance in Fig. 2 under the curve of the hydraulic fluid without additive there would occur a straight line approximately parallel to it, but rathermore the conductivity increases steeply, as is illustrated by the following Example and Fig. 3. This effect of the additives according to the invention is singularly surprising, because it considerably exceeds the usual increase in conductivity by adding e.g. salts to aqueous fluids.

The substances used according to the invention are to be added in amounts in the order of 0.5 to 2%, preferably between 0.8 and 1.5%, based on the hydraulic fluid.

An especially interesting secondary effect of the sodium salicylate was also that in spite of a 2% water content in the hydraulic fluid, a drop in its boiling point can be largely prevented.

EXAMPLE

1% sodium salicylate was added to a hydraulic brake fluid, as is normally employed for motor vehicles and is sold under the trademark "Castrol".

The conductivity of "Castrol" without the additive according to the invention was 0.5 μS in the anhydrous condition and 8 μS with 2% water. When the sodium salicylate was added to this fluid, the conductivity increased to 10 μS with 0% water and to about 38 μS with 2% water (see Fig. 3).

CLAIMS

1. A hydraulic fluid which contains one or more additives which are selected from carboxylic acids, salts of carboxylic acids, alkanolamines, amides and thioamides which are soluble in the fluid and in any water present in the fluid to form ions.

2. A hydraulic fluid as claimed in Claim 1, of a type based on one or more of mineral oils, polyglycols, polyglycol ethers and silicones with the optional inclusion of one or more of the usual additives.

3. A hydraulic fluid as claimed in Claim 1 or 2, wherein the alkanolamines are ethanolamines e.g. mono-, di-, tri-ethanolamines.

4. A hydraulic fluid as claimed in Claim 1, 2 or 3, containing 0.5 to 2% of said one or more additives forming ions.

5. A hydraulic fluid as claimed in Claim 1, 2 or 3, containing 0.8 to 1.5% of said one or more additives forming ions.

6. A hydraulic fluid as claimed in any preceding claim, wherein the or one of additives is an aromatic hydroxycarboxylic acid or a salt thereof.

7. A hydraulic fluid as claimed in Claim 6, containing sodium salicylate.

8. A hydraulic fluid as claimed in Claim 1, substantially as hereinbefore described.

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